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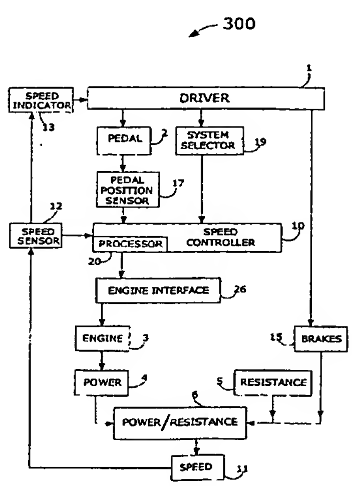
(54) **Title:** A VEHICLE SPEED CONTROL SYSTEM



(57) **Abstract:** The Speed Control System, or SCS, uses a software-driven processor for control of the transmission drive of a vehicle. The driver may select a Speed Control Mode to set the speed of the vehicle, or commands a speed change, while the processor adapts the output of the engine to match the desired speed. This contrasts with standard cars, where the driver controls the engine's output. With the SCS the driver may select from various speed curves, either linear or not, set a maximum speed and define maximum acceleration. Control of the SCS is achieved by the same conventional "gas pedal" now renamed "speed pedal" or "pedal" for short. In Acceleration Control Mode, the driver may select from various acceleration curves, set maximum acceleration, and define the maximum speed allowed. The SCS also provides a platform for the passive and active external monitoring and control of the vehicle's speed.

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A VEHICLE SPEED CONTROL SYSTEM

Technical Field

The present invention relates generally to the driving of vehicles and in particular to the control of the speed of the vehicle.

Background Art

Motorized vehicles are well known *per se* for many decades and are used daily by millions of people. Conventionally, vehicles such as cars are steered with a driving wheel and are powered by an internal combustion engine. The driver controls the engine through an acceleration pedal, or gas pedal, while power from the engine is transmitted to the drive train through a gearbox. In the begin of the motorized era, only the manual-shift gearbox was known. Later on, to facilitate the task of the driver and avoid the need for shifting gears, automatic transmissions were introduced. However, although the automatic transmission is a relief, the driver is still compelled to constantly and continuously control the speed of his vehicle by the combined use of the gas pedal and/or the brakes.

As a further improvement, cruise controls systems were introduced for driving on freeways. These cruise controls allow the driver to set a selected speed that the system will maintain automatically until the speed setting is canceled by the driver when, for example, the brakes are depressed.

A schematic block diagram of a conventional system for driving a car is depicted in Fig 1. The diagram is simplified and focuses on the functions relevant to the present invention. The driver 1 is shown to be in command of the gas pedal 2' that controls the engine 3. The output of the engine 3 is power 4 that balances the resistance 5 to the motion of the vehicle. For example, the resistance 5 is either internal resistance such as friction losses in the engine or the transmission, or external resistance caused by the road surface roughness, road inclination, or aerodynamic drag. The power/resistance balance 6 is monitored by the driver 1 who closes the control loop and who is the controller of the system 100. It is thus seen that the driver 1 directly

controls the engine 3 through the gas pedal 2' to indirectly derive a chosen vehicle speed. In conventional car driving systems, there is no way for the driver to directly command the speed of the vehicle, unless for freeway driving by help of a cruise control system.

Many are aware of the shortcomings of the existing vehicle driving systems and try to relieve the load imposed on the driver. For example, French Patent No. 2728835, by Millet, uses a key-pad for the driver to input the required cruise speed and a speed at which further pedal depression meets suddenly increased stiffness thus effectively converting the gas pedal to a foot-rest. This feature may add to the comfort of the driver but does little to assist in the driving process. In addition, Danno et al., in WO Patent No. 9008886 teach an engine output control apparatus, with engine output adjusting means, for adjusting the output of the engine with regard to various control targets such as prevention of wheel slippage and constant speed running of the vehicle. Furthermore, Kawata et al., in Japanese Patent No. 86193841, propose a vehicle speed control apparatus comprising means for controlling the operation of an automatic transmission in such a way that the transmission shifts into another gear according to vehicle speed and associated parameters. While probably useful, these apparatus do not permit but indirect control over the speed of the vehicle. Thus, in spite of the advantages, which would be provided by such systems, no practical way of putting the driver in direct control of the speed of the vehicle is yet available.

The need for proper control over the speed of a driven vehicle is addressed by the three following US Patents, all of which rely on intricate mechanisms and some try to couple the conventional cruise control system with the traditional gas pedal. The first US Patent No. 4,541,052, in the name of McCulloch, discloses a device wherein the gas pedal functions conventionally as long as movement of the pedal is detected. Once the pedal is held still for 2 to 3 seconds, then, the cruise speed of the vehicle is kept constant. In the second US Patent No. 4,605,409, in the name of Küpper et al., there is proposed a spring loaded device which provides a snap-in detent to separate the path of the gas pedal in a range of deceleration and a range of acceleration. The third US Patent No. 5,012,418, in the name of Petzold presents a speed-regulated

system for a motor vehicle which senses the position of two pedals, namely the brakes and the gas pedal. None of these patents provides a speed control system presenting the ability to continuously control either the speed or the speed change of the driven vehicle.

It is a purpose of this invention to provide a solution permitting the driver of a vehicle to continuously control either the speed change or the speed of a vehicle.

Summary of the Invention

It is an object of the present invention to provide a speed control system to serve as an improved vehicle control system, which is more suited to the needs of a driver and makes driving more enjoyable.

It is also an object of the present invention to provide a practical way to put the driver of a vehicle in direct command of the speed of the vehicle and of the speed change of the vehicle. This approach is opposed to the derivation of speed, by control of the output of the engine that provides power, to overcome resistance, resulting in speed.

It is another object of the present invention to provide convenient speed selection options according to the wishes of the driver.

It is yet another purpose of the present invention to allow the driver to select a driving style according to the acceleration permitted, suiting either personal preferences, or which are in accordance with prevailing road and/or climate conditions and furthermore, to select other driving styles at will.

It is still another object of the present invention to allow the driver to select and set a driving speed not to be exceeded and to reset that maximum speed at will.

One further object of the present invention is to confer to the driver the ability to drive the vehicle by commanding a succession of speeds with the option of selecting either a constant speed, or a change of speed.

Preferably, there is provided a speed control system for use by the driver of a vehicle, the vehicle having brakes, an automatic transmission and an engine to impart

both a speed and a speed change capability to the vehicle. The speed control system preferably comprises:

a pedal comprising:

a first fully released state and a second fully depressed state, and

a pedal range spanning from the first state to the second state,

a pedal position chosen by the driver,

a pedal position sensor coupled to the pedal, the pedal position sensor for deriving the position of the pedal in the pedal range,

a speed controller coupled to the pedal position sensor for receiving pedal position information therefrom, the speed controller comprising:

a processor for control and operation of the speed control system,

predetermined instructions comprising:

instructions for the distribution of the pedal range into at least a first pedal range portion and a second pedal range portion, and

instructions for interpretation of the pedal position in the first pedal range portion and in the second pedal range portion as commands, respectively for keeping the speed of the vehicle constant and for imparting speed to the vehicle,

an engine interface coupled to the speed controller and to the engine, the engine interface for receiving commands from the speed controller and for performing commands and for transmitting commands to the engine, and

a speed sensor for deriving the speed of the vehicle, the speed sensor being coupled to the speed controller for providing vehicle speed information thereto, for the speed controller to process the pedal position information in association with the predetermined instructions and with speed information to generate commands for the engine to change the speed of the vehicle and alternatively, to maintain the speed of the vehicle constant, according to the pedal position.

It is another object of the present invention to provide predetermined instructions for the speed control system which comprise:

instructions for distribution of the pedal range into at least a first pedal range portion, a second pedal range portion and a third pedal range portion,

instructions for association, respectively, of the first pedal range portion as being adjacent to the first fully released state of the pedal, and of the third pedal range portion as being adjacent to the second fully depressed state of the pedal, and of the second pedal range portion as being intermediate the first pedal range portion and the third pedal range portion, and

instructions for interpretation of the pedal position in the first pedal range portion and in the second pedal range portion and in the third pedal range portion as commands for, respectively, decreasing the speed of the vehicle, keeping the speed of the vehicle constant and increasing the speed of the vehicle.

It is yet another object of the present invention to provide further predetermined instructions which comprise:

instructions for interpretation of the pedal position in the first pedal range portion and in the second pedal range portion and in the third pedal range portion, as commands for imparting to the vehicle, respectively, a negative speed change, a constant speed and a positive speed change, and

at least one monotonous speed change curve represented as instructions commanding the speed change according to the pedal position in the pedal range, the at least one monotonous speed change curve comprising at least a negative speed change portion starting with an upper negative speed change, a constant speed portion, and a positive speed change portion ending in an upper positive speed change, and

instructions for distribution of the at least one monotonous speed change curve in correspondence with the pedal range, for the upper negative speed change to correspond with the fully released state of the pedal and for the upper positive speed change to correspond with the fully depressed state of the pedal. The absolute value of the upper positive speed change and the absolute value of the upper negative speed change are predetermined independent absolute values.

In addition, the constant speed portion is a discrete pedal position in the pedal range.

It is still another object of the present invention to provide further predetermined instructions which comprise:

at least one speed change control parameter for fixing discrete limits to the upper positive and to the upper negative speed change of the vehicle, and

a procedure for resetting the monotonous speed change curve over the pedal range according to discrete limits fixed for the upper positive and for the upper negative speed change, and

the speed control system further comprises:

a speed change selector having at least one engagement position, the speed change selector being coupled to the speed controller and operable by the driver for selection of one of the at least one speed change control parameter(s) and engagement of the speed change selector into the at least one engagement position.

Still another object of the present invention is to provide further predetermined instructions which comprise:

one default speed change control parameter selected from the at least one speed change control parameter(s),

the speed change selector further comprises:

one engagement position for the one default speed change control parameter selected by the driver. The default speed change control parameter is automatically engaged by the speed controller unless the driver selects a speed change control parameter.

It is one more object of the present invention to provide a speed control system which comprises:

at least one speed control parameter for fixing discrete speed limit to the upper speed of the vehicle, and

the speed control system further comprises:

a speed selector comprising at least one engagement position, the speed selector being coupled to the speed controller and operable by the driver for engageable selection of one of the at least one speed control parameter(s).The default speed control parameter is automatically engaged by the speed controller unless the driver has engaged one speed control parameter in the speed change selector. Evidently, if there is only one speed control parameter, there is no need for a speed control selector.

Another object of the present invention is to provide a speed control system with predetermined instructions which further comprise:

instructions for association of the first pedal range portion and of the second pedal range portion as being adjacent to, respectively, the first fully released state of the pedal and the second pedal fully depressed state of the pedal,

a distribution of speeds, the distribution of speeds comprising a plurality of monotonously increasing discrete speeds starting from speed zero adjacent to the first pedal range portion and ending in maximum vehicle speed in the fully depressed state of the pedal, and

instructions for association of the distribution of speeds according to pedal positions in the second pedal range portion. Evidently, the first pedal range portion may be defined as a discrete pedal position.

Furthermore, it is an object of the present invention to provide a speed control system wherein:

the pedal range comprises:

a range of pedal positions starting from a pedal position for speed zero and ending in an upper speed, and

the predetermined instructions comprise:

at least one monotonous speed curve represented as instructions commanding the speed against the pedal position in the pedal range, the at least one speed curve having a speed starting from speed zero and increasing to an upper speed, and

instructions for distribution of the at least one monotonous speed curve in correspondence with the pedal range, for zero speed to correspond with a pedal

position in the fully released state portion of the pedal range and for the upper speed to correspond with the fully depressed state of the pedal.

The speed control system further comprises:

at least one speed control parameter for fixing discrete limit to the upper speed of the vehicle, and

a procedure for resetting the monotonous speed curve against the pedal position in the pedal range according to the discrete speed limit, and

the speed control system further comprises:

a speed selector having at least one engagement position, the speed selector being coupled to the speed controller and operable by the driver for selection of one of the at least one speed control parameter(s) and engagement of the speed selector into the at least one engagement position.

There is also provided one default speed control parameter selected as one from the at least one speed control parameter(s), and

the speed selector further comprises:

one engagement position for the one default speed control parameter selected by the driver.

One default speed control parameter is automatically engaged by the speed controller unless the driver has engaged one speed control parameter in the speed selector. Evidently, if there is only one speed control parameter, there is no need for a speed control selector.

Furthermore, it is an object of the present invention to provide a speed control system which comprises:

at least one speed change control parameter for setting discrete limits to the upper positive and to the upper negative speed change of the vehicle, and

a procedure for computing the speed change of the vehicle, and

the speed control system further comprises:

a speed change selector having at least one engagement position, the speed change selector being coupled to the speed controller and operable by the driver for selection of one of the at least one speed change control parameter(s) and

engagement of the speed change selector into the at least one engagement position.

As stated above, the absolute value of the upper positive speed change limit and the absolute value of upper negative speed change limit are independent absolute values. The speed control system also comprises

one default speed change control parameter selected from the at least one speed change control parameter(s),

the speed change selector further comprises:

one engagement position for the one default speed change control parameter selected by the driver.

The one default speed change control parameter is automatically engaged by the speed controller unless the driver has engaged one speed change control parameter in the speed change selector. Evidently, if there is only one speed change control parameter, there is no need for a speed change control selector.

Yet one more object of the present invention is to provide a speed control system comprising predetermined instructions for application of the brakes according to limits of the engaged speed change control parameter when required for remaining inside limits imposed by the speed change control parameter and for application of the brakes according to limits of the engaged speed control parameter when required for remaining inside limits imposed by the speed control parameter.

An additional object of the present invention is to provide a speed control system comprising a graphical display unit for presentation of data, the graphical display unit allowing the driver to select data contained in the speed controller, starting from car manufacture day to the present instant, in real time. The speed control system also further comprises a communication unit coupled to the speed controller, the communication unit for transmitting data residing in the speed controller and for receiving data and instructions for loading in the speed controller. The speed controller will respond and control the vehicle according to requests received and identified as being authorized.

A last objective of the present invention is to provide for a speed control system wherein the speed control system further comprises:

a system selector coupled to the speed controller and operable by the driver of the vehicle, the system selector allowing the driver to select conventional vehicle operation and speed controller operation and the system selector also allowing the driver to select between speed and speed change systems.

BRIEF DESCRIPTION OF THE DRAWINGS

In order to understand the invention and to see how it may be carried out in practice, preferred embodiments will now be described, by way of non-limiting example only, with reference to the accompanying drawings, in which:

Fig. 1 is a block diagram of a simplified conventional car driving system;

Fig. 2 schematically illustrates the speed control system according to the present invention, using the same conventions as in Fig. 1;

Fig. 3 depicts a more detailed version of Fig. 2, representing a first embodiment;

Fig. 4 shows positions of a pedal in various regions along the range of travel of the pedal which allows a driver to control a vehicle by help of the present invention;

Fig. 5a is a qualitative diagram of the change of speed in response to the pedal, in accordance with Fig. 4;

Fig. 5b is a special case of the diagram of the change of speed illustrated in Fig. 5a;

Fig. 6 is a qualitative diagram of the speed in response to the pedal, in accordance with Fig. 4; and

Fig. 7 schematically illustrates another embodiment, with improved features, in comparison with the embodiment shown in Fig. 3.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

Fig. 1 is a simplified conventional car-driving system 100 depicted in block-diagram form. Here, a driver 1 operates an accelerator pedal 2', or gas pedal 2', to signal to the engine 3 to supply more or less engine power 4. The power 4 of the engine is needed to overcome resistance 5 encountered by the vehicle, either as internal resistance such as friction losses, for example, in the engine or the in transmission, or as external resistance, caused by the road surface roughness, road inclination, or aerodynamic drag.

By applying engine power 4 against the resistance 5, a balance of power-to-resistance ratio 6 is reached. That ratio 6 imparts speed 11 to the vehicle, which speed is fed back to the driver 1 who controls the vehicle. It is for

the driver 1 to continuously evaluate the speed 11 resulting from the power/resistance ration 6 and to respond accordingly. As described above, the driver 1 is in fact the controller of the system 100.

Fig. 2 is a block-diagram of the speed control system 200 using the same conventions as in Fig. 1 and having many diagram blocks in common therewith. In the following, similar characters of reference indicate corresponding elements. The diagram of Fig. 2 is used to explain the basic principles of the speed control system 200 according to the present invention. The speed control system 200 is seen to be used by the driver 1 who operates a speed pedal 2, in the same conventional manner as the gas pedal 2' described in Fig. 1. The following refers to a car equipped with a conventional driving system, namely an automatic transmission, either with or without a cruise control system, but in either case, possessing a speed control system 200. In Fig. 2, the speed pedal 2, or pedal 2, interacts with a speed controller 10, designated hereafter as SC 10, that will be explained in details below. Commands, or signals, from the speed controller 10, or SC 10 for short, are sent to the engine 3. Again as in Fig. 1, the engine 3 delivers engine power 4 to counter the resistance 5 offered to the vehicle, resulting in a power-over-resistance ratio 6. Because of this ratio 6, a vehicle speed 11 is generated and that speed is read by a speed sensor 12 for feedback to the SC 10.

With the speed control system 200, it is the SC 10 that is in charge of maintaining the speed of the vehicle, while the driver 1 commands the choice of vehicle speed 11 by means of the pedal 2 that becomes in this case a "speed control pedal", as will be explained below. In other words, with the system 200 of Fig. 2, the control loop is closed by the SC 10 and not by the driver 1, in contrast with the system 100 in Fig. 1. Once the driver 1 has chosen a desired driving speed, the SC 10 maintains the speed constant but, if the driver so wishes, that speed may be changed at any moment without the need for intricate settings. When compared to a conventional cruise control system, the difference is that the speed control system 200 offers an instantaneously and continuously selectable

speed-setting capability as opposed to cruise control that is limited to a chosen speed that may be discretely reset. The driver 1 is only required to chose the speed of travel he wishes to maintain without being bound to accommodate for external condition influencing changes of speed, such as road inclination, wind speed, and the like.

A specific embodiment of the speed control system is illustrated in Fig. 3 as system 300, where the numerals used in the previous figures are retained. Also shown are conventional devices such as a speed indicator 13 and brakes 15, all operable by the driver. The functioning of the speed control system 300 will now be explained, starting with the SC 10.

The SC 10 is a controller comprising a processor 20 preloaded with data and predetermined instructions and programmed to manage and control the operation of the speed control system 300. Only the SC 10 is shown in Fig. 3 while the conventional automatic transmission, and the cruise control if available, are deleted for the sake of clarity. As stated above, the SC 10 does not preclude the use of a cruise control system.

As a first step, since the driver 1 has to convey his choice of speed by operation of the pedal 2, the SC 10 must be provided with information about the position of the pedal 2. Then, as a second step, the SC 10 must be programmed to respond to the specific position of the pedal 2. Therefore first, to derive positional information, a pedal position sensor 17 is coupled to the pedal 2 and to the SC 10. The pedal position sensor 17 signals to the SC 10, for example, whether the pedal 2 is either fully depressed to the floor, or if totally released. Then second, a set of predetermined instructions, preloaded into the SC 10, interpret the significance to be given to the pedal 2 position and generate the expected response in association with other parameters, some of them possibly provided by the driver 1, as will be explained below. Those predetermined instructions are the agreed conventions that associate the position of the speed pedal 2 with the response of the SC 10. The response signals from the SC 10, derived by help of a processor 20 comprised in the SC 10, are then fed into the engine interface 26 for translation to operative

instructions, or signals, which are transmitted to the engine 3. As explained above, power 4 from the engine 3 is balanced against the resistance 5 to provide a power to resistance ratio 6 resulting in vehicle speed. 11.

A speed sensor 12 is coupled to the SC 10 to provide speed data thereto and to close the control loop. The speed sensor 12 may also be coupled to a speed indicator for the benefit of the driver 1. The conventional brakes system 15 is also available to the driver 1 for the increase of resistance 5.

According to preferred embodiments, two different approaches may be derived in response to the position of the pedal 2. These are the "speed change" approach and the discrete "speed" approach. Any of both approaches may be implemented: the choice is left to the manufacturer or to the customer. It will be explained below that a system selector 19 is available to the driver 1 for the selection of the desired approach.

With reference to Fig. 4, the pedal 2 is depicted in various positions, from the totally released position R to the fully depressed pedal position D, also called "pedal to the metal". The pedal 2 is loaded with a spring, not shown in Fig. 4 for the sake of clarity, for return of the pedal 2 from the depressed position D to the released position R. A pedal end-stop E limits the travel of the pedal 2.

The following example illustrates the "speed change" approach. It is assumed that the total range 30 of the pedal 2, may be divided, for example, into three consecutive portions, each portion covering a sector of the total range 30. When the driver 1 wants an increase of speed, then the pedal 2 is depressed into the lowest portion of travel 31, the one closest to the floor, but to keep the instant speed constant, then the pedal is released to the middle portion 32. to remain there. In contrast, a decrease of speed is obtained by returning the pedal 2 to the upper range 33. Evidently, the SC 10 is pre-programmed to respond accordingly.

To graphically illustrate the preceding explanation, Fig. 5a is now referred to, where a diagram of the speed change dV, or the acceleration dV, is presented with reference to a system of coordinates. The ordinate dV indicates the speed change, positive above the abscise and negative thereunder. The abscise from the

origin O to the point S, represents the range of travel of the pedal 2, thus equivalent to the range from R to D in Fig. 4, or to the angle 30. Fig. 5a shows one curve ranging from 34 to 36, but other curves may be chosen. In Fig. 5a, the three portions of the range of travel are shown as a pedal lower portion 31, a mid-range portion 32 and an upper portion 33, similarly to Fig. 4. Thanks to the flexibility inherent with software controlled systems, the controller 10 may be programmed to fit any arbitrary choices regarding the number of portions that divide the range of travel from R to D, and to the length of each one of the portions. The term "software" is used as a synonym of "computer program", all the portions may be either equal in length, or span different lengths, or feature a combination of possibilities. It is seen in Fig. 5a that in the middle portion 35-35' of the curve 34 to 36, the speed is constant, while the more pedal 2 is depressed into the lower-pedal-position portion 31, thus into the upper part of the curve 34 to 35, the speed increase demanded from the vehicle is higher. In the "higher up" pedal 2 position, referring to portion 33, from point 35' to point 36, the contrary is true, as speed change decrease, or deceleration, is called for. The diagram of Fig. 5a is only one illustration, as the shape of the speed change curve 34 to 36 may be chosen differently.

For example, instead of a flat portion 35 to 35' as in Fig. 5a, one may consider to diminish the zero-acceleration portion 35-35' of the speed-change curve, and to shrink it to nil, to become a single point P. That point P bridges between the deceleration portion 35' to 36 and the acceleration portion 34-35 of the speed-change curve 34 to 36. Both points 35 and 35' have thus merged into the single point P. An example is shown with reference to Fig. 5b, where the speed change curve is now chosen to be linear, thus with constant change of acceleration from the abscise crossing point P to the upper point 34, and with constant change of the deceleration from the point P to the point 36. In contrast with the operation of a conventional gas pedal, the point P is not a point of equilibrium found by the driver 1, with him acting as a controller that compensates for disturbances, but rather a point of zero acceleration or constant

velocity, as programmed into the SC 10. All along the speed change curve 34 to 36, the driver 1 is thus master of the acceleration, positive, negative, or null, irrespectively from external influences. Figuratively speaking, it is the driver 1 who positions his vehicle, by command of the pedal 2, on the straight line 34 to 36 of Fig. 5a, to select the speed change. Once the driver 1 has reached the desired speed, he returns the pedal 2 to the point P to keep the speed constant. As was explained above, constant speed may be retained at a singular point P or along a flat portion 35 to 35', as best suited to accommodate the driver 1.

The curves of Figure 5a or of Figure 5b thus represent the output of the SC 10 correspond to the input provided by the pedal 2, through the pedal position sensor 17. As the predetermined instruction curves for the SC 10 are of parametric nature and are controlled by software, it is possible to impose limiting values as control parameters influencing the response to the pedal 2 position commands.

In other words, even though the SC 10 is preloaded with predetermined instructions, it is possible to restrict the response of the SC 10 according to control parameters, either as chosen by the driver 1 or as pre-loaded.

The rate of change of the speed, thus the rate of the acceleration, will now be considered as a control parameter.

It is well known that various rates of acceleration accommodate different driving conditions. For example, in dangerous driving conditions, such as on ice, in snow, sleet, or rain, the rate of change of the speed is best limited to low values to prevent loss of control of the vehicle due to tire slip. Very low acceleration obviously prevail for driving on slippery roads. Other rates of acceleration may also refer to the kind intended to achieve maximum fuel economy or to allow "sportive" driving. Evidently, for maximum fuel economy, the engine 3 should not be allowed to generate fast changes of speed. However, sportive driving should permit the driver 1 to urge the SC 10 to extract all the available power from the engine 3, because fast accelerations are desired.

Figure 5b that depicts the change of acceleration against the range of travel of the pedal 2, is now referred to again. The slope of the solid line 34 to 36 is a measure of the acceleration, with the upper point 34 and the lower point 36 representing, accordingly, the highest acceleration and the lowest acceleration that the driver 1 may command. These highest and lowest accelerations are also called, respectively, the upper positive speed change and upper negative speed change. Considering the dashed line 34' to 36' that features a lesser slope than the line 34 to 36, it is evident that the extreme acceleration 34' and minimal deceleration 36' have been lowered. Still, the range of the pedal 2 has remained the same.

Since an acceleration curve, say 34 to 36, may consist of a set of predetermined parametric instructions loaded in the SC 10, the control parameters are read and the acceleration curve is processed accordingly, by help of the processor 20. The dashed curve 34' to 36' is thus an implementation of parametric processing performed on the curve 34 to 36. It is obvious that an increased slope will result in augmented acceleration, and lower deceleration will be caused by a decreased slope. As already stated above, any practical shape of curve may be selected within the capabilities of the vehicle, the wishes of the driver 1 and road-safety considerations. Obviously, the limiting acceleration is bound by the characteristics of the vehicle and those can not be surpassed.

In practice, a driver 1 will be able to chose from different acceleration options available, and select between, e.g., maximum fuel economy, normal driving, bad weather and sportive driving, as will be explained below. In principle, there is no restriction to the addition of more acceleration control parameters.

Besides a maximum rate of change of the speed, it is also feasible to introduce a maximum speed as a limiting control parameter.

As the speed control system 300, shown in Figure 3, is equipped with a speed sensor 12 coupled to the SC 10, it is easy to add a speed control parameter to the control process. Therefore, should the driver 1 want to limit his speed *a priori,*

then the SC 10 will comply by taking the limitations of the speed control parameter into account. Besides personal driving speed predilections, there are speed limits imposed by law as well as by safety considerations. Known examples include municipal, inter-city and free way speed limits enforced by the police. Visibility restrictions, such as in fog or heavy rain, will call for safety-imposed speed limitations. Further explanations regarding practical implementation will be offered below.

It was stated above that two different approaches would be exposed regarding the response to the interpretation of the speed pedal position. Now after the speed change approach was explained in length, the discrete speed approach will be presented. Figure 4, that illustrates possible positions of the speed pedal 2, will be used in conjunction with Figure 6, to explain the discrete speed approach and the associated limiting parameters.

The graph of Figure 6 depicts a coordinate system comprising a full-line speed curve, with the speed V of the vehicle as the ordinate, against the range of travel S of the pedal 2, as the abscise. The full range of depression of the pedal 2 is shown in Fig. 6 as starting at the origin O of the axes and ending at the end point 34, corresponding to Fig. 4, where the range of the pedal 2 spans the angle 30, starting from R and ending with D. The curve O-34 is pictured as a straight line with a constant slope, to keep the explanations simple. Evidently, the range of travel O to S may be subdivided into any number of portions and the speed curve 0-34 may be shaped at will as a monotonous curve of chosen shape. A speed curve may be pre-loaded in the SC 10 during manufacture, either as a simple curve or as a distribution of curves from which the driver 1 may select the one curve he prefers.

The full line O -34 of Figure 6 represents a distribution of discrete speed settings ranging from zero at the origin O, to the maximum speed of the vehicle at the end point 34 of the speed curve. Each position of the pedal 2 is thus associated with a discrete speed. When the speed curve is a straight line as in Figure 6, the maximum speed achieved with a fully depressed pedal 2 depends on the slope of

the line O-34. Therefore, it is easy to understand that when limiting parameters such as a maximum speed control parameter is applied, such as, for example, for city driving with a maximum speed of 50 km/h, the slope of the curve may be reset and lowered by the SC 10, as shown by the line O-34'. Still, a specific position of the pedal 2, is related to a specific point on the speed curve O-34', but the maximum speed is constrained. The points on the dashed curve O-34' have been redistributed along the pedal travel range from O to 34. In contrast, for freeway driving, a steep slope may be set, as for the dotted line from O to 34" that will allow a high maximum speed.

Because the speed curve O to 34 is a parametric curve loaded into he SC 10, preprogrammed instructions will enable that curve to be modified according to control parameters. The SC 10 will easily derive a new speed curve adapted to parameters chosen by the driver 1, to reset the slope of the speed curve.

The other limiting control parameter besides the speed control parameter is the change of speed or the acceleration, which is the ratio of speed over time. With the discrete speed approach, the SC 10 will use the speed data that is fed back by the speed sensor 12 (see Figure 3) to derive the acceleration corresponding to time intervals given by the clock of the processor 20. The SC 10 will therefore be able to process the change of speed of the vehicle and to constrain it according to a given acceleration control parameter. For example, on an icy road, it is best to keep the permitted acceleration very low, besides maintaining a low speed, as for example, the input of various values for a PID into a control system intended for the pursuit of a target.

An integrated and improved embodiment 400 will now be presented, with reference to Figure 7, and the various components of the speed control system 400 will be explained. All the elements shown in Figure 3 are present in Figure 7. Additional components operated by the driver and shown in Figure 7, are a maximum acceleration selector 37 and a maximum speed selector 38. Other elements that appear in Figure 7 are a brakes interface 27, a display 39 and a data communication device 42.

The function of the newly added devices will be explained first and after that, the functioning of the integrated speed control system 400. The added devices comprise the maximum acceleration selector 37 and the maximum speed selector 38.

The system selector 19 is a device useful for the choice of system. The driver 1 may use the system selector 19 to engage any of the three methods, either the speed change approach, the discrete speed approach or the conventional driving system. A car may be built with system selector 19 to provide choice between any of the three methods, or only between the two SC 10 supported approaches. In addition, no choice, thus either with the speed change or with the discrete speed approach, is also an option. In practice, it might be only the SC 10 that needs to be selected, if so desired. The contrary is also true: the default position might be the speed control system, as will be assumed now, and the option is to engage the conventional driving system. Evidently, a car might be equipped only with the speed control system.

In the following, it is assumed either that the speed control system is the single option, equivalent to having the SC 10 engaged.

A vehicle outfitted with the speed control system 400 might be manufactured with a pedal responding to either the change of speed approach or the discrete speed approach. With the change of speed, the pedal 2 controls the acceleration or the declaration of the vehicle, as was described above with reference to Figs. 4, 5a and 5b. However, with the discrete speed, each position of the gas pedal 2 is related to a specific speed, as was presented in relation to Figs. 4 and 6.

Two parameter control selectors are also provided to the driver 1: the maximum acceleration selector 37 and the maximum speed selector 38.

A conscious driver 1 may want to limit the maximum acceleration of his vehicle. Most of the time, acceleration limitation will improve fuel efficiency and reduce costs. Sometimes, heavy rain or ice, snow and sleet on the roads will call for extremely low acceleration to prevent sliding. The maximum acceleration

selector 37 may thus comprise many engagement positions, amongst others, for normal driving, sportive driving, optimal fuel economy and slippery roads. Such maximum acceleration constraints must be loaded as pre-programmed instructions into the SC 10, from factory. The default engagement position may be chosen, for example, as optimal economy, but whatever the preference, at least one position of the selector must be engaged, either as selected by the driver or by default.

Maximum speed of travel is controlled by a selector 38 in response to traffic regulations or to personal inclinations of the driver 1. The speed limits are preprogrammed as instructions loaded into the SC 10, to comply with, e.g. city driving, inter-city commuting and free way travel. A driver 1 may want to prevent inadvertent speeding by imposing a maximum speed limit. Possible positions of engagement for a maximum speed selector 38 may include, for example: 30 km/h, 50 km/h, 90 km/h and 120 km/h. The engagement positions provided depend on the manufacturer of the vehicle and the selection depends on the responsibility of the driver 1. Obviously, one possible choice should be selected, intentionally or by default.

The speed control system 400 of Fig. 7 also features a brakes interface 27 for the control of the brakes 15 by the SC 10. When deceleration is called for as commanded by the position of the pedal 2, the brakes interface 27, that is coupled between the SC 10 and the brakes system 15, may come into action. For example, when the maximum acceleration selector 37 is engaged in the sportive driving position, the SC 10 may apply the brakes 15 to comply with sharp deceleration commands. In this example of the automatic application of the brakes, it is irrelevant with what pedal response approach the vehicle is equipped, as both the speed change and the discrete speed approach may demand a sharp reduction in vehicle velocity. However, the automatic application of the brakes in response to system commands is limited to a narrow range of accelerations, as the SC 10 will not call for an emergency stop but will function only according to the allowed acceleration/deceleration limits. Evidently, for the sake of safety, the brakes 15

always remain operable by the driver 1, in all circumstances, regardless of any selector setting.

For the convenience of the driver 1, a graphic display 39 is also coupled to the SC 10, as also shown in Figure 7. The display 39 may serve for presentation of the selected driving speed, of the actual vehicle speed or of the settings of the various selectors as well as for the display of any other parameters regarding the vehicle, its driving or history of data. As an example, suppose that the driver 1 engages the system selector 19 to the discrete speed approach, the acceleration selector 37 in the maximum economy position, and the maximum speed selector 38 to the speed position for freeway travel. Assuming that the vehicle travels at 60 km/h but that the pedal 2 is suddenly depressed to the position associated with say, 90 km/h, then clearly, as maximum fuel economy is selected with the acceleration selector 37, the change of speed will be rather slow, certainly slower than for the sportive driving option. It will take some time before the vehicle catches up with the requested speed. This is now when the display 39 comes to use: both the speed selected by the driver 1 and the actual vehicle speed will be shown, with the actual speed continuously increasing until the selected speed is reached. Another example where the display 39 is useful is when the cruise control position is engaged: the last chosen speed may be displayed. Still further, the display 39 may show the selected speed curve, or the selected acceleration curve, and the corresponding actual position of the pedal 2 on the curve. The driver 1 may also watch his speed selections and/or other speed relate data on the graphic display 39.

In addition, as the SC 10 stores and processes data, it is possible to couple thereto a data communication unit 42, to transmit data and/or receive data, respectively, to and from external sources. It may therefore be possible for authorized sources to communicate from a station with the data communication unit 42 and cause the transmission of, amongst other data, information about the selected speed and the actual speed of the vehicle. In the same manner, control commands from authorized external sources may cause the SC 10 to alter the

speed of the vehicle, e.g. as a measure of caution before reaching a construction area, or a traffic bottleneck, or a roadblock.

Now that the various underlying principles, techniques and elements have been exposed, the integrated speed control system 400 will be explained according to Figure 7. The explanations will be presented from the point the view of a driver 1 making use of the speed control system 400 and of the different optional controls and engagement positions. Driving with a conventional automatic transmission and with a cruise control system will not be explained, as they are both well-known systems.

With reference to Figure 7, the driver 1 first starts the engine 3. Then, if the vehicle is not solely fitted with the speed control system or that the speed control system is not the default option, the driver 1 must, secondly, engage the system selector 19 in the speed control position and make an approach, speed change or discrete speed, selection.

As a third step, either before driving away or during the ride, the maximum acceleration controller 37 must be engaged, either by the driver 1 or by default. For a vehicle with the speed-change pedal response approach, the selected position of the maximum acceleration selector 37 will set the slope of the acceleration curve 34-36, shown in Figure 5b. Sportive driving, thus high acceleration, will call for a steep curve slope, such as shown by the dotted line 34" to 36" in Figure 5b, but for slippery-road driving, it is curve 34' to 36' that is representative, with a shallow slope. However, if it is the discrete speed pedal response approach that is implemented, then it is up to the SC 10 to limit the acceleration. This is achieved by help of the speed sensor 12 and of the clock of the processor 20, by calculation of the acceleration according to pre-loaded instructions. It is then up to the SC 10 to stop further acceleration when there is a signal that an acceleration limit has been reached.

In a fourth step, taken either before or after starting to drive the vehicle, the setting of the maximum speed controller 38 is chosen, either by driver selection or by default. The maximum speed, for example for freeway or for city

driving, will be selected on the speed controller 38 and will become a limiting parameter for the vehicle's response to the pedal 2 position. With the speed curve approach, it is figure 6 that pictures the response. A higher speed limit will raise the slope of the nominal speed curve 0 to 34, such as shown by the dotted line 0 to 34". Else, for a low speed, the dashed line 0 to 34' depicts the response along the range of the pedal 2.

Even if it is the speed change approach that is implemented, speed data is still available, as continuously fed from the speed sensor 12 to the SC 10. It is thus feasible to retrieve appropriate signals to restrain the speed of the vehicle.

In the above, mention was made to the pedal 2 and to the pedal position sensor 17 for the operation of the SC 10. This was done because historically, it is the pedal that controls the engine of a car. The reason for this is that a pedal on the floor presents a simple way to couple a command element from the driver's cabin to the engine compartment by way of a mechanical link. However, as the SC 10 is controlled "by wire", other elements besides a pedal may be used. For example, a lever or a handle, as in tractors, boats and airplanes, might replace the pedal 2. The same might be achieved with a wheel, or a knob. Furthermore, it is possible to attach a slider, or a thumb-wheel, or a finger-wheel on the steering wheel itself, where the driver 1 keeps both hands. Thereby, the driver 1 could control the engine 3 by hand and not by foot. It thus follows that the term "pedal" in association with the speed control system 400, or with the SC 10, may be regarded as a generic term. Although "pedal" is mentioned, any other displacement control element could be used.

While preferred embodiments of the invention have been described in detail, it should be apparent that many modifications and variations thereto are possible, all of which fall within the true spirit and scope of the invention. For example, a processor may be replaced by an array of processors or other processing means. In addition, other configurations of the selectors and of the pedal settings are possible.

It is therefore intended by the appended claims to cover any and all such applications, modifications and embodiments within the scope of the present invention.

CLAIMS:

1. A speed control system for use by the driver of a vehicle, the vehicle having brakes, an automatic transmission and an engine to impart both a speed and a speed change capability to the vehicle, the speed control system comprising:

a pedal comprising:

a first fully released state and a second fully depressed state,

a pedal range spanning from the first state to the second state, and

a pedal position chosen by the driver,

a pedal position sensor coupled to the pedal, the pedal position sensor for deriving the position of the pedal in the pedal range,

a speed controller coupled to the pedal position sensor for receiving pedal position information therefrom, the speed controller comprising:

a processor for control and operation of the speed control system, and

predetermined instructions comprising:

instructions for distribution of the pedal range into at least a first pedal range portion and a second pedal range portion, and

instructions for interpretation of the pedal position in the first pedal range portion and in the second pedal range portion as commands, respectively for keeping the speed of the vehicle constant and for imparting speed to the vehicle,

an engine interface coupled to the speed controller and to the engine, the engine interface for receiving commands from the speed controller and for performing commands and for transmitting commands to the engine, and

a speed sensor for deriving the speed of the vehicle, the speed sensor being coupled to the speed controller for providing vehicle speed information thereto,

for the speed controller to process the pedal position information in association with the predetermined instructions and with speed information to generate commands for the engine to change the speed of the vehicle and alternatively, to maintain the speed of the vehicle constant, according to the pedal position.

2. The predetermined instructions according to Claim 1, wherein the predetermined instructions further comprise:

instructions for distribution of the pedal range into at least a first pedal range portion, a second pedal range portion and a third pedal range portion,

instructions for association, respectively, of the first pedal range portion as being adjacent to the first fully released state of the pedal, and of the third pedal range portion as being adjacent to the second fully depressed state of the pedal, and of the second pedal range portion as being intermediate the first pedal range portion and the third pedal range portion, and

instructions for interpretation of the pedal position in the first pedal range portion and in the second pedal range portion and in the third pedal range portion as commands for, respectively, decreasing the speed of the vehicle, keeping the speed of the vehicle constant and increasing the speed of the vehicle.

3. The predetermined instructions according to Claim 2, wherein the predetermined instructions further comprise:

instructions for interpretation of the pedal position in the first pedal range portion and in the second pedal range portion and in the third pedal range portion, as commands for imparting to the vehicle, respectively, a negative speed change, a constant speed and a positive speed change, and

at least one monotonous speed change curve represented as instructions commanding the speed change according to the pedal position in the pedal range, the at least one monotonous speed change curve comprising at least a negative speed change portion starting with an upper negative speed change, a constant speed portion, and a positive speed change portion ending in an upper positive speed change, and

instructions for distribution of the at least one monotonous speed change curve in correspondence with the pedal range, for the upper negative speed change to correspond with the fully released state of the pedal and for the upper positive speed change to correspond with the fully depressed state of the pedal.

4. The predetermined instructions according to the Claims 2 and 3, wherein the absolute value of the upper positive speed change and absolute value of the upper negative speed change are predetermined independent absolute values.

5. The pedal range according to the Claims 3 and 4, wherein the constant speed portion is a discrete pedal position in the pedal range.

6. The speed control system according to Claim 3, wherein the predetermined instructions further comprise:

at least one speed change control parameter for fixing discrete limits to the upper positive and to the upper negative speed change of the vehicle, and

a procedure for resetting the monotonous speed change curve over the pedal range according to discrete limits fixed for the upper positive and for the upper negative speed change, and

the speed control system further comprises:

a speed change selector having at least one engagement position, the speed change selector being coupled to the speed controller and operable by the driver for selection of one of the at least one speed change control parameter(s) and engagement of the speed change selector into the at least one engagement position.

7. The predetermined instructions according to Claim 6, wherein absolute value of upper positive speed change limit and absolute value of upper negative speed change limit are independent predetermined absolute values.

8. The speed control system according to Claim 6, wherein:

the predetermined instructions further comprise:

one default speed change control parameter selected from the at least one speed change control parameter(s),

the speed change selector further comprises:

one engagement position for the one default speed change control parameter selected by the driver.

9. The speed change selector according to the Claims 6 and 8, wherein:

one default speed change control parameter is automatically engaged by the speed controller unless the driver has engaged one speed change control parameter in the speed change selector.

10. The speed control system according to Claim 3, wherein

the predetermined instructions further comprise:

at least one speed control parameter for fixing discrete speed limit to the upper speed of the vehicle, and

the speed control system further comprises:

a speed selector comprising at least one engagement position, the speed selector being coupled to the speed controller and operable by the driver for engageable selection of one of the at least one speed control parameter(s).

11. The speed control system according to Claim 10, further comprising:

one default speed control parameter selected from the at least one speed control parameter(s), and

the one default speed control parameter being selectable by the driver.

12. The speed change selector according to the Claims 10 and 11, wherein:

the default speed control parameter is automatically engaged by the speed controller unless the driver selects one speed control parameter.

13. The speed control system according to Claim 1, wherein:

the predetermined instructions further comprise:

instructions for association of the first pedal range portion and of the second pedal range portion as being adjacent to, respectively, the first fully released state of the pedal and the second pedal fully depressed state of the pedal,

a distribution of speeds, the distribution of speeds comprising a plurality of monotonously increasing discrete speeds starting from speed zero adjacent to the first pedal range portion and ending in maximum vehicle speed in the fully depressed state of the pedal, and

instructions for association of the distribution of speeds according to pedal positions in the second pedal range portion.

14. The speed control system according to Claim 13, wherein:

the first pedal range portion is a discrete pedal position.

15. The speed control system according to Claim 13, wherein

the pedal range comprises:

a range of pedal positions starting from a pedal position for speed zero and ending in an upper speed, and

the predetermined instructions comprise:

at least one monotonous speed curve represented as instructions commanding the speed against the pedal position in the pedal range, the at least one speed curve having a speed starting from speed zero and increasing to an upper speed, and

instructions for distribution of the at least one monotonous speed curve in correspondence with the pedal range, for zero speed to correspond with a pedal position in the fully released state portion of the pedal range and for the upper speed to correspond with the fully depressed state of the pedal.

16. The speed control system according to Claim 15, wherein

the predetermined instructions further comprise:

at least one speed control parameter for fixing discrete limit to the upper speed of the vehicle, and

a procedure for resetting the monotonous speed curve against the pedal position in the pedal range according to the discrete speed limit, and

the speed control system further comprises:

a speed selector having at least one engagement position, the speed selector being coupled to the speed controller and operable by the driver for selection of one of the at least one speed control parameter(s) and engagement of the speed selector into the at least one engagement position.

17. The speed selector according to Claim 16, wherein:

the predetermined instructions further comprise:

one default speed control parameter selected as one from the at least one speed control parameter(s), and

the speed selector further comprises:

one engagement position for the one default speed control parameter selected by the driver.

18. The speed selector according to the Claims 16 and 17, wherein:

one default speed control parameter is automatically engaged by the speed controller unless the driver has engaged one speed control parameter in the speed selector.

19. The speed control system according to Claim 15, wherein

the predetermined instructions further comprise:

at least one speed change control parameter for setting discrete limits to the upper positive and to the upper negative speed change of the vehicle, and

a procedure for computing the speed change of the vehicle, and

the speed control system further comprises:

a speed change selector having at least one engagement position, the speed change selector being coupled to the speed controller and operable by the driver for selection of one of the at least one speed change control parameter(s) and engagement of the speed change selector into the at least one engagement position.

20. The predetermined instructions according to Claim 19, wherein

absolute value of upper positive speed change limit and absolute value of upper negative speed change limit are independent absolute values.

21. The speed control system according to Claim 19, wherein:
the predetermined instructions further comprise:

one default speed change control parameter selected from the at least one speed change control parameter(s),

the speed change selector further comprises:

one engagement position for the one default speed change control parameter selected by the driver.

22. The speed change selector according to the Claims 19 and 21, wherein:

one default speed change control parameter is automatically engaged by the speed controller unless the driver has engaged one speed change control parameter in the speed change selector.

23. The speed controller according to the Claims 8 and 19, wherein
the predetermined instructions further comprise:

predetermined instructions for application of the brakes according to limits of the engaged speed change control parameter when required for remaining inside limits imposed by the speed change control parameter.

24. The speed controller according to the Claims 10 and 16, wherein
the predetermined instructions further comprise:

predetermined instructions for application of the brakes according to limits of the engaged speed control parameter when required for remaining inside limits imposed by the speed control parameter.

25. The speed control system according to all the preceding Claims, further comprising:

a graphical display unit for presentation of data, the graphical display unit allowing the driver to select data contained in the speed controller starting from car manufacture day to present instant.

26. The speed control system according to all the preceding Claims, further comprising:

a communication unit coupled to the speed controller, the communication unit for transmitting data residing in the speed controller and for receiving data and instructions for loading in the speed controller.

27. The speed control system according to all preceding Claims, wherein the speed control system further comprises:

a system selector coupled to the speed controller and operable by the driver of the vehicle, the system selector allowing the driver to select between conventional vehicle operation and speed controller operation.

28. The speed control system according to Claim 27, wherein

the system selector allows the driver to select between speed and speed change systems.

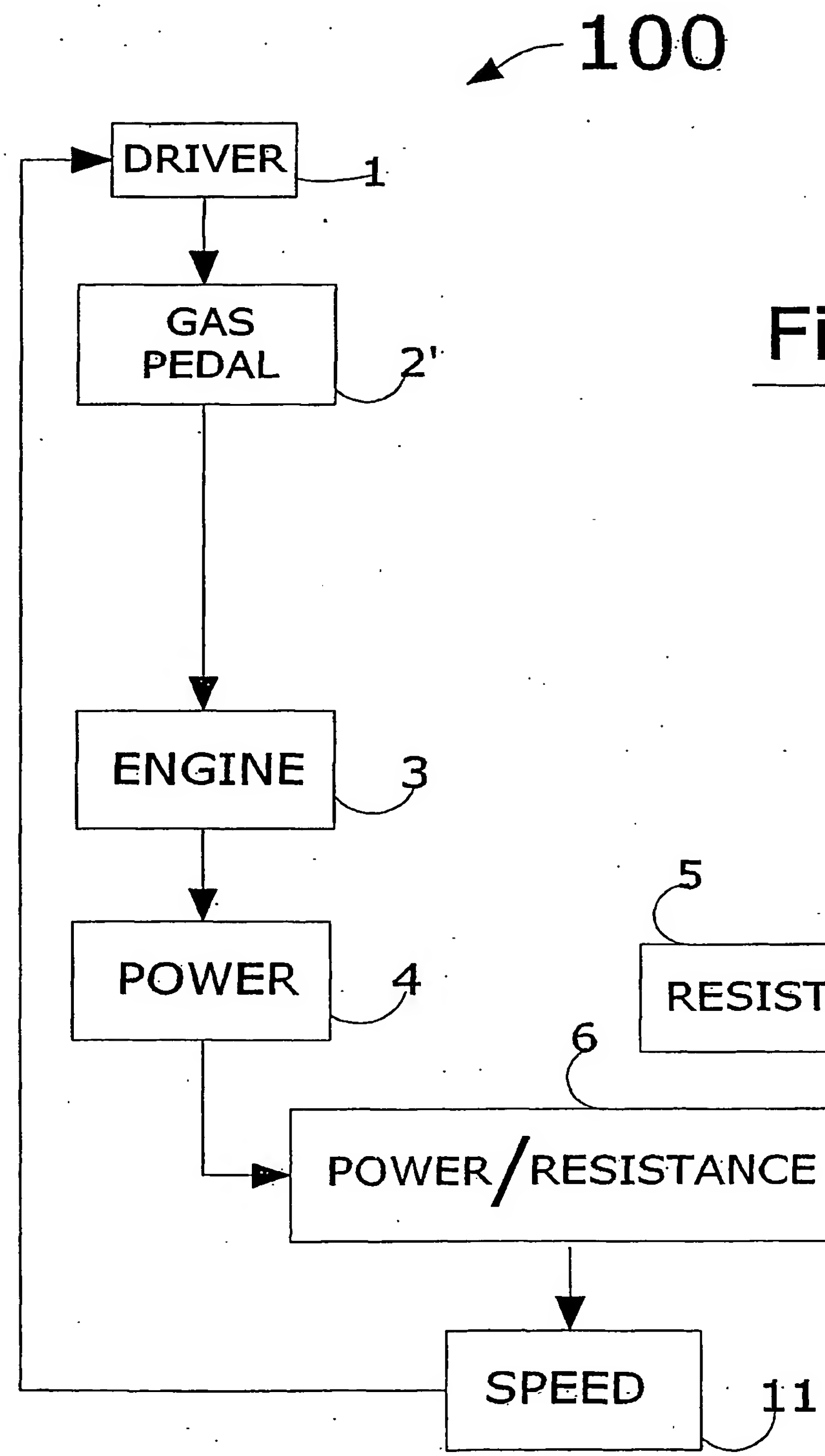
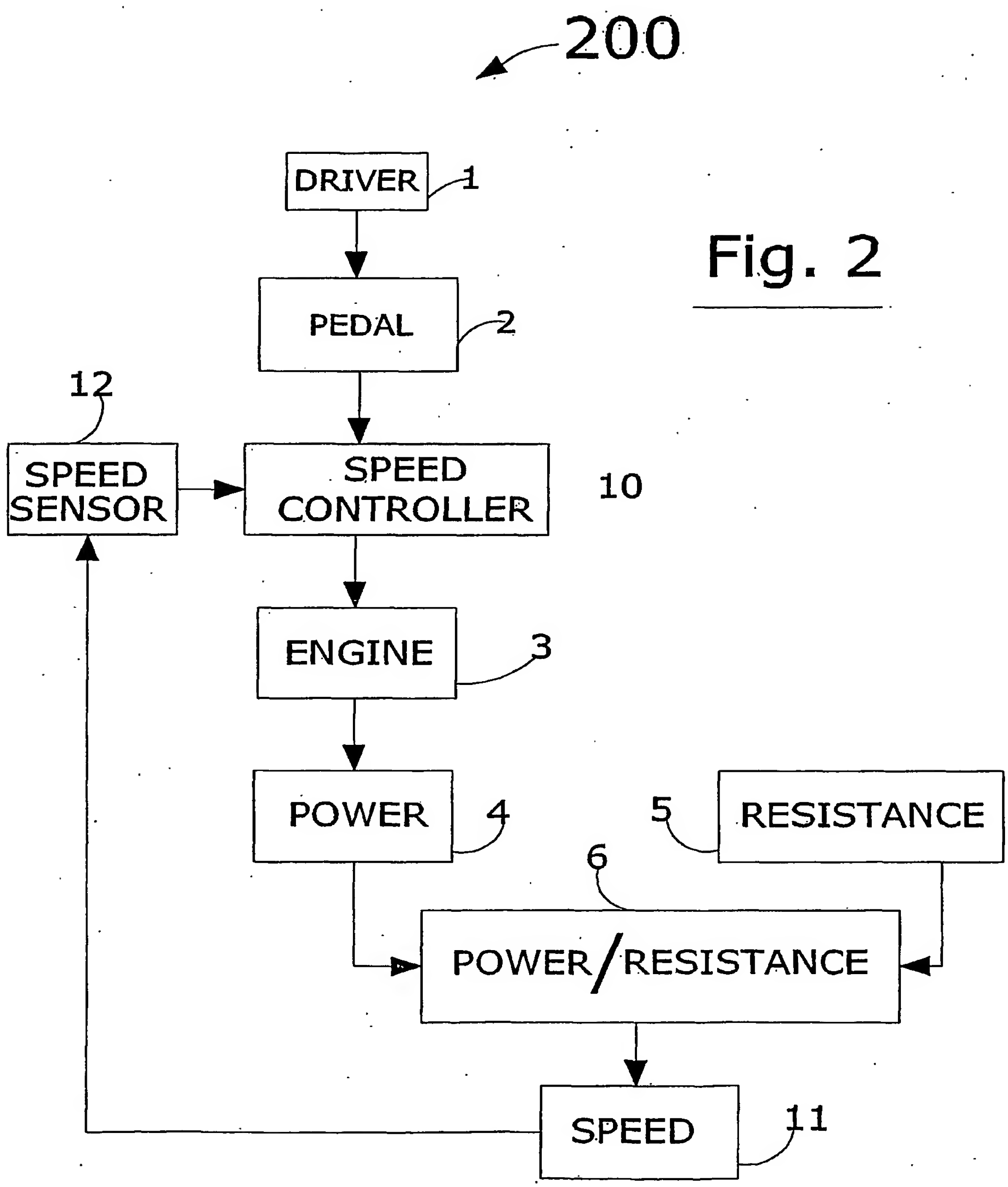

100
DRIVER
1
GAS PEDAL
2'
ENGINE
3
POWER
4
5
RESISTANCE
6
POWER/RESISTANCE
SPEED
11

Fig. 1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PEDAL
2
12
SPEED SENSOR
SPEED CONTROLLER
10
ENGINE
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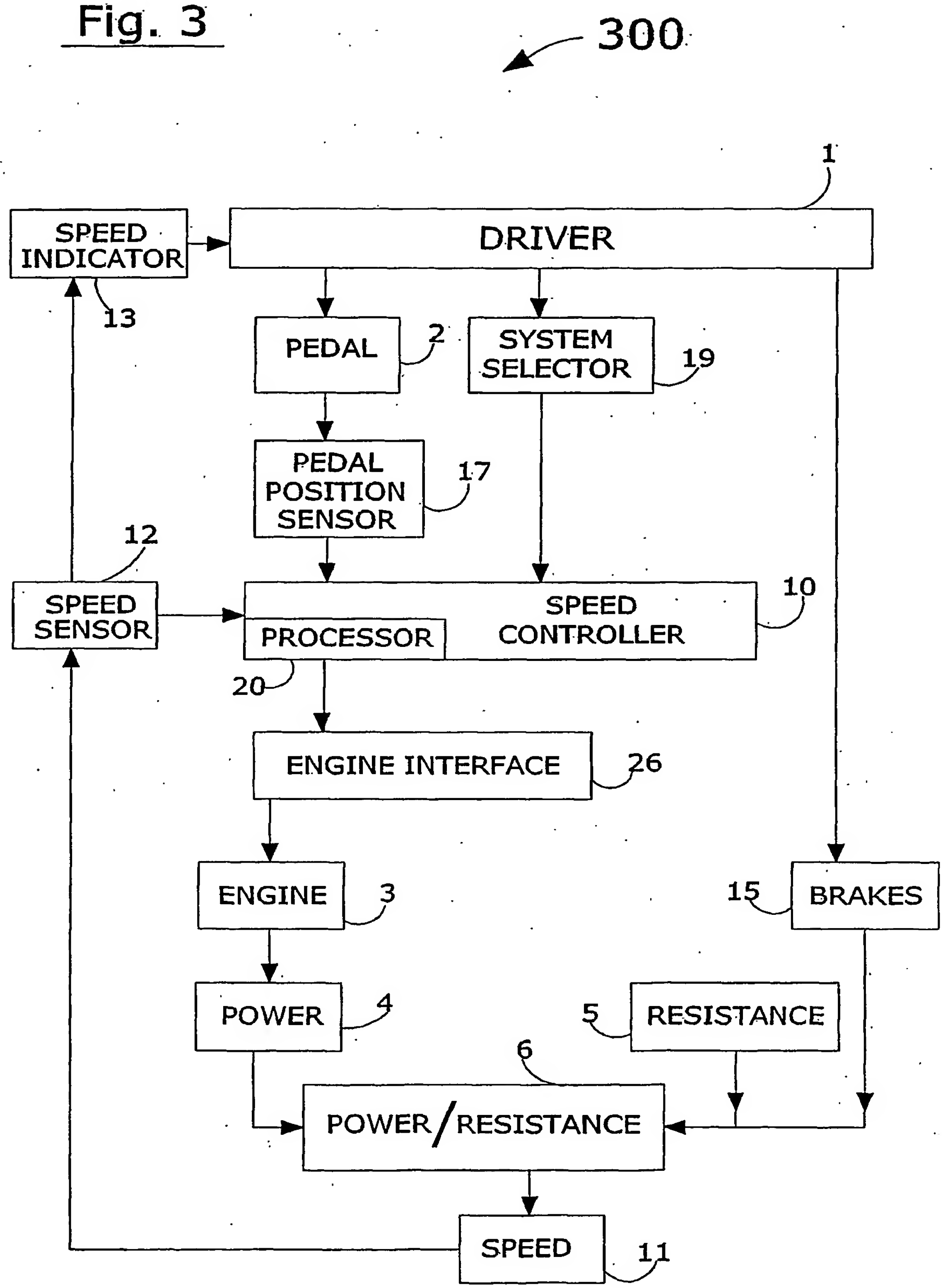
5
RESISTANCE
6
POWER/RESISTANCE
SPEED
11

Fig. 2

Fig. 3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1
DRIVER
SPEED INDICATOR
13
PEDAL
2
SYSTEM SELECTOR
19
PEDAL POSITION SENSOR
17
12
SPEED SENSOR
SPEED CONTROLLER
PROCESSOR
10
20
ENGINE INTERFACE
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ENGINE
3
15
BRAKES
POWER
4
5
RESISTANCE
6
POWER/RESISTANCE
SPEED
11

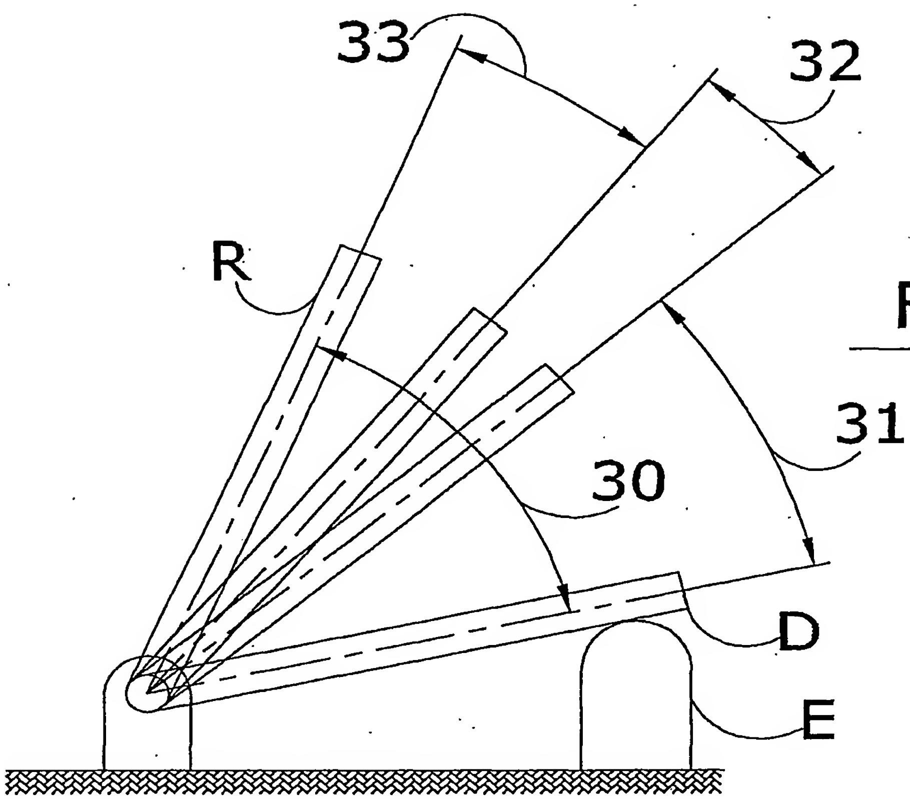


Fig. 4

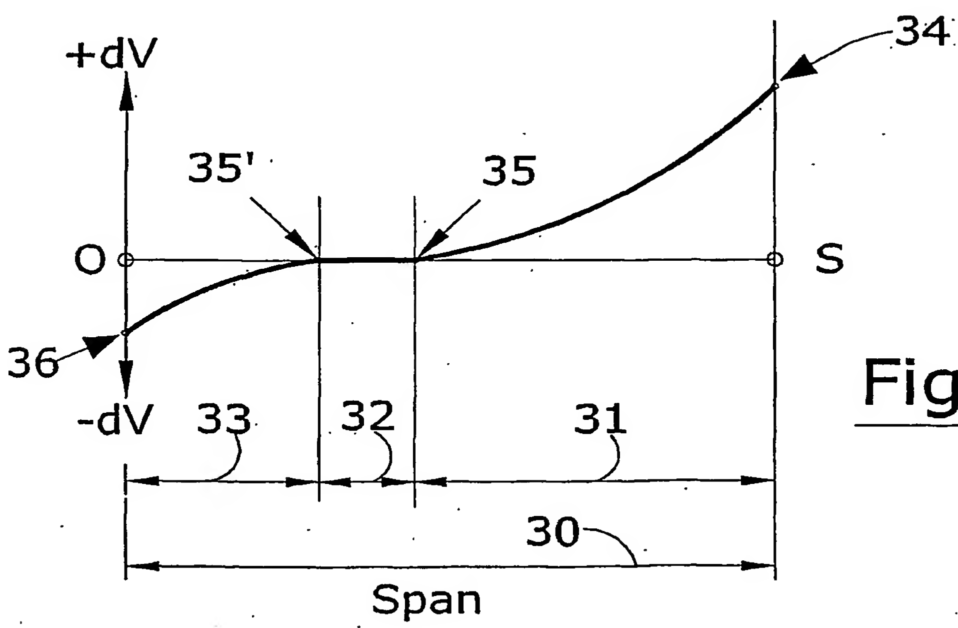


Fig. 5a

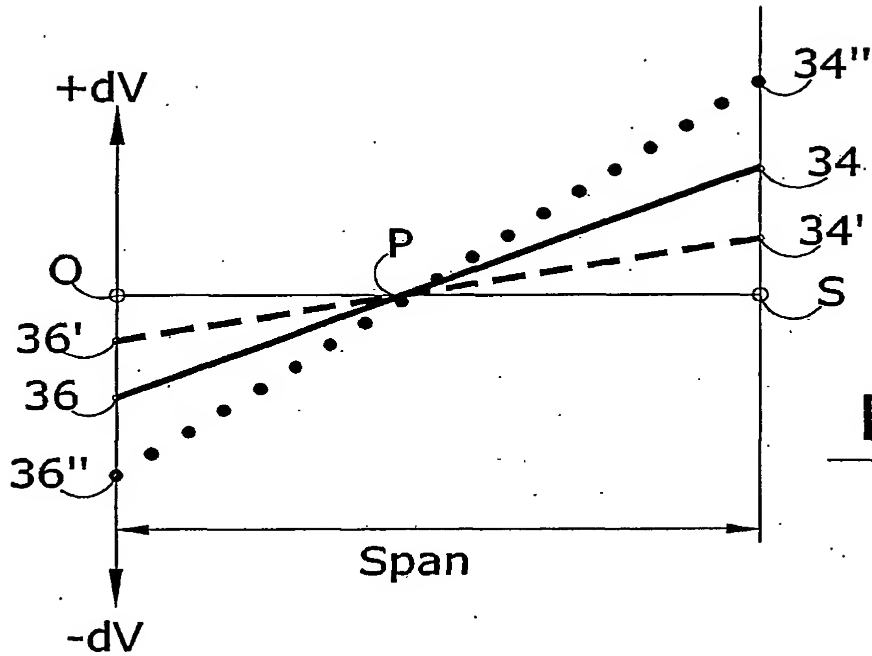


Fig. 5b

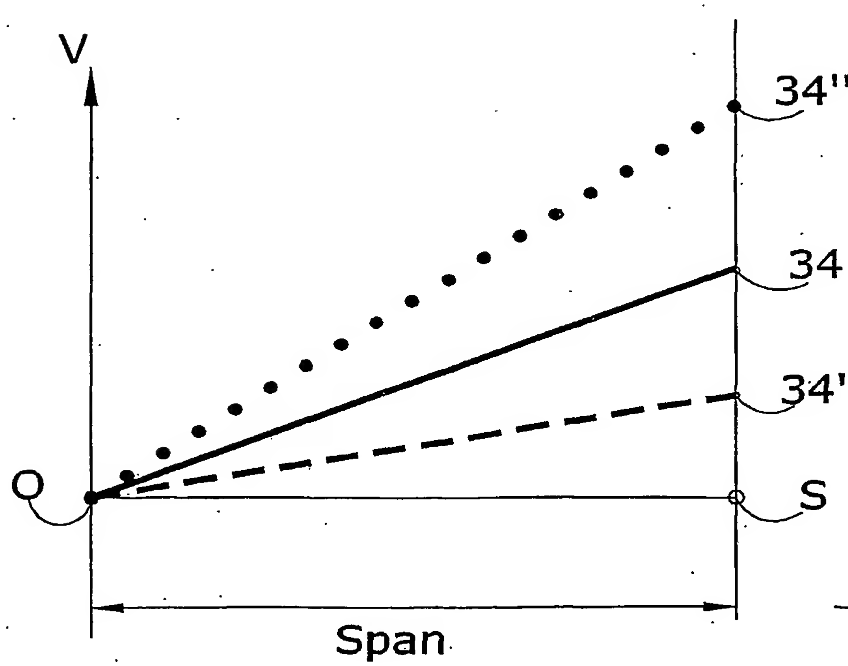
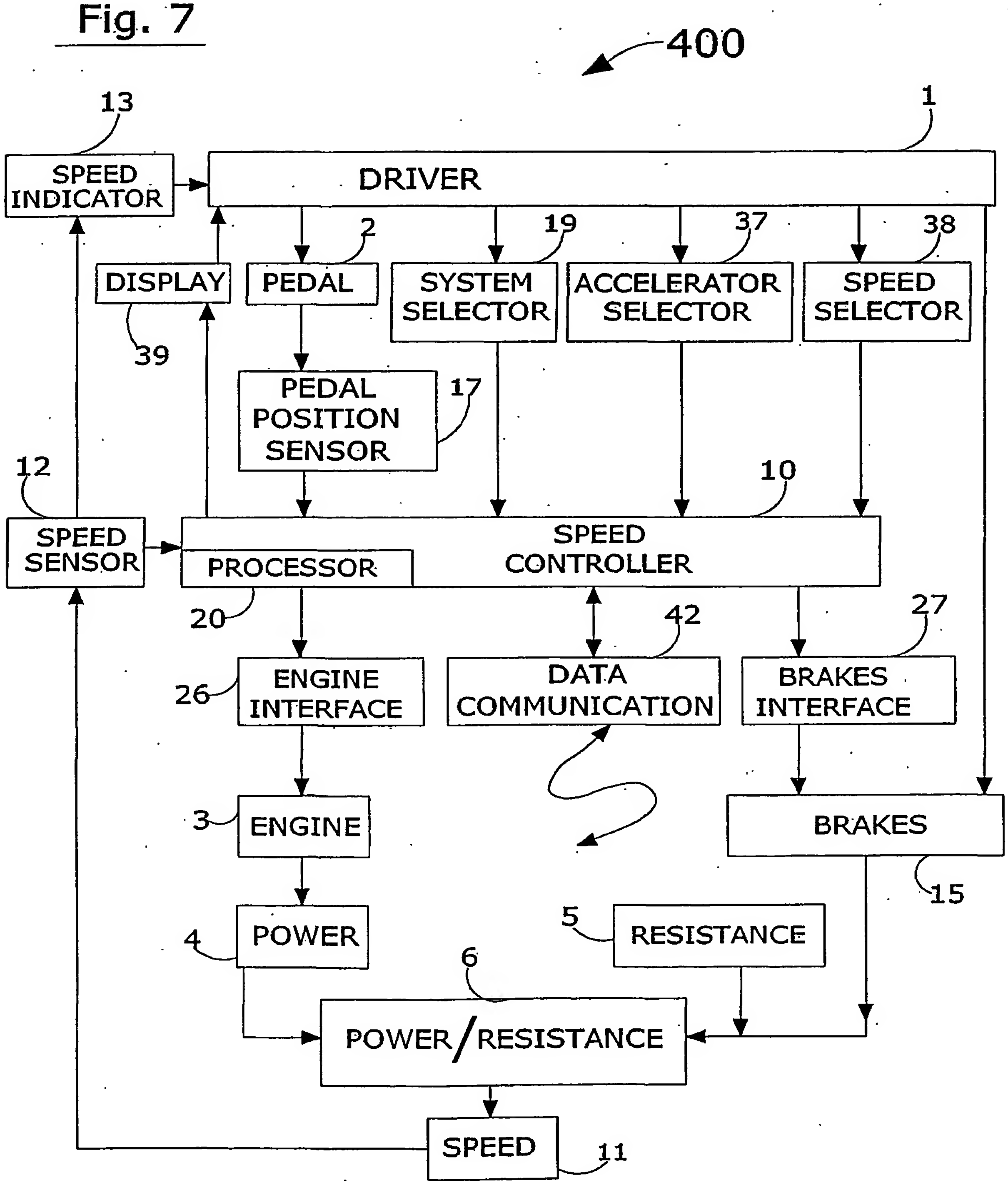


Fig. 6

Fig. 7


400
13
1
SPEED INDICATOR
DRIVER
2
19
37
38
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PEDAL
SYSTEM SELECTOR
ACCELERATOR SELECTOR
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39
PEDAL POSITION SENSOR
17
12
10
SPEED SENSOR
SPEED CONTROLLER
PROCESSOR
20
42
27
26
ENGINE INTERFACE
DATA COMMUNICATION
BRAKES INTERFACE
3
ENGINE
BRAKES
15
4
POWER
5
RESISTANCE
6
POWER/RESISTANCE
SPEED
11